Claims

1. A vibration isolator comprising:

a housing;

a piston resiliently disposed within housing, the piston being adapted for connection to a first body;

a first fluid chamber and a second fluid chamber defined by the housing and the piston;

a tuning port placing the first fluid chamber and the second fluid chamber in fluid communication;

a tuning mass disposed within the tuning port; and

at least one actuator coupled to the piston for selectively transferring forces to the piston.

2. The vibration isolator according to claim 1, wherein the tuning mass is a fluid.

3. The vibration isolator according to claim 1, wherein the tuning mass is a solid material.

4. The vibration isolator according to claim 1, further comprising:

at least one flow diverter aligned with the tuning port for directing the flow of a tuning fluid.

5. The vibration isolator according to claim 1, further comprising:

a gas accumulation chamber in fluid communication with the first fluid chamber for collecting and accumulating gas from the first fluid chamber, the second fluid chamber, and the tuning port.

6. The vibration isolator according to claim 1, wherein the length of the tuning port is adjustable.

7. The vibration isolator according to claim 1, wherein the tuning port is exterior to the housing.

8. The vibration isolator according to claim 1, wherein the tuning port is integrated into the wall of the housing.

9. The vibration isolator according to claim 1, wherein the actuator is a piezoelectric actuator.

10. A vibration isolator comprising:

a housing;

a first piston resiliently disposed within the housing, the first piston being adapted for connection to a vibrating body;

a second piston resiliently disposed within the housing;

at least one piezoceramic actuator coupled to the second piston for selectively transferring forces to the second piston;

a first fluid chamber and a second fluid chamber, each being defined by the housing, the first piston, and the second piston;

a tuning port in fluid communication with both the first fluid chamber and the second fluid chamber; and

a tuning fluid disposed within the first fluid chamber, the second fluid chamber, and the tuning port.

11. The vibration isolator according to claim 10, further comprising:

a gas accumulation chamber in fluid communication with the first fluid chamber or the second fluid chamber for collecting and accumulating gas from the first fluid chamber, the second fluid chamber, and the tuning port.

12. The vibration isolator according to claim 11, wherein the gas accumulation chamber is positioned below either the first fluid chamber or the second fluid chamber, and is in fluid communication with the first fluid chamber or the second fluid chamber through a passage having a one-way valve that allows the fluid to pass

therethrough only when the pressure of the fluid chamber to which it is in fluid communication is greater than the pressure of the gas accumulation chamber.

13. The vibration isolator according to claim 10, wherein the tuning port is exterior to the housing.

14. The vibration isolator according to claim 10, wherein the tuning port is integrated into the wall of the housing.

15. The vibration isolator according to claim 10, further comprising:

a second tuning port in fluid communication with both the first fluid chamber and the second fluid chamber;

a means associated with the second tuning port for providing an additional degree of freedom;

wherein vibrations at two different frequencies are isolated.

16. The vibration isolator according to claim 15, wherein the vibrations are harmonic.

17. The vibration isolator according to claim 15, wherein the means for providing the additional degree of freedom is a spring-mass member.

18. The vibration isolator according to claim 15, wherein the means for providing the additional degree of freedom is a piston for which the action is restrained by a spring.

19. The vibration isolator according to claim 10, wherein the actuator is a piezoelectric actuator.

20. A vibration isolator comprising:

a base portion adapted for connection to a first body;

a housing;

a tuning mass resiliently carried within the housing;

at least one piezoceramic actuator disposed between the base portion and the housing for selectively transferring forces to the housing.

21. A dual frequency vibration absorber comprising:

a housing;

a first piston resiliently disposed within the housing, the first piston being adapted for connection to a first body;

a second piston resiliently disposed within the housing;

at least one actuator coupled to the second piston for selectively transferring forces to the second piston;

a first fluid chamber and a second fluid chamber, each being defined by the housing, the first piston, and the second piston;

a first tuning port in fluid communication with both the first fluid chamber and the second fluid chamber;

a second tuning port in fluid communication with both the first fluid chamber and the second fluid chamber;

a means associated with the second tuning port for providing an additional degree of freedom; and

a tuning fluid disposed within the first fluid chamber, the second fluid chamber, the first tuning port, and the second tuning port.

wherein the first tuning port allows isolation of harmonic vibration at a first selected frequency, and the second port allows isolation of vibration at a second selected frequency.

22. The vibration isolator according to claim 21, wherein the means for providing the additional degree of freedom is a spring-mass member.

23. The vibration isolator according to claim 21, wherein the means for providing the additional degree of freedom is a piston for which the action is restrained by a spring.

24. The vibration isolator according to claim 21, comprising:

additional tuning ports;

a means associated with each additional tuning port for providing an additional degree of freedom;

wherein each additional tuning port allows isolation of vibration at a corresponding additional selected frequency.

25. A vibration isolator comprising:

a housing;

a first piston resiliently disposed within the housing, the first piston being adapted for connection to a first body;

a second, multistage piston resiliently disposed within the housing, the second, multistage piston, being configured to define a first plurality of stages in fluid communication with a first fluid chamber, and a second plurality of stages in fluid communication with a second fluid chamber;

at least one actuator coupled to the second, multistage piston for selectively transferring forces to the second, multistage piston;

a first fluid chamber and a second fluid chamber, each being defined by the housing, the first piston, and the second, multistage piston;

at least one tuning port in fluid communication with both the first fluid chamber and the second fluid chamber; and

a tuning fluid disposed within the first fluid chamber, the second fluid chamber, and the tuning port.

26. The vibration isolator according to claim 25, wherein the actuator is a piezoelectric actuator.

27. The vibration isolator according to claim 25, wherein the individual stages of the first plurality of stages and the individual stages of the second plurality of stages are configured in an alternating arrangement.

28. A vibration isolator comprising:

a housing;

a first, multistage piston resiliently disposed within the housing, the first, multistage piston, being configured to define a first plurality of stages in fluid communication with a first fluid chamber, and a second plurality of stages in fluid communication with a second fluid chamber;

a second piston resiliently disposed within the housing, the second piston being adapted for connection to a first body;

at least one actuator coupled to the first, multistage piston for selectively transferring forces to the first, multistage piston;

a first fluid chamber and a second fluid chamber, each being defined by the housing, the first, multistage piston, and the second piston;

at least one tuning port in fluid communication with both the first fluid chamber and the second fluid chamber; and

a tuning fluid disposed within the first fluid chamber, the second fluid chamber, and the tuning port.

29. A vibration isolator for isolating the vibration of rotating machinery from a structure comprising:

a housing adapted for connection to the structure;

a first piston resiliently disposed within the housing;

mounting plate coupled to the first piston, the mounting plate being adapted for connection to the rotating machinery;

a second piston resiliently disposed within the housing;

at least one piezoceramic actuator coupled to the second piston for selectively transferring forces to the second piston;

a first fluid chamber and a second fluid chamber, each being defined by the housing, the first piston, and the second piston;

a tuning port in fluid communication with both the first fluid chamber and the second fluid chamber; and

a tuning fluid disposed within the first fluid chamber, the second fluid chamber, and the tuning port;

wherein the transmission of structural-borne vibration from the rotating machinery to the structure is precluded.

30. The vibration isolator according to claim 29, wherein the precluded vibration is in the range of the natural frequency of the structure.

31. The vibration isolator according to claim 29, further comprising:

a gas accumulation chamber in fluid communication with the first fluid chamber for collecting and accumulating gas from the first fluid chamber, the second fluid chamber, and the tuning port.

32. The vibration isolator according to claim 29, wherein the tuning port is exterior to the housing.

33. The vibration isolator according to claim 32, further comprising:

a protective skirt surrounding the tuning port to protect the tuning port from damage and debris.

34. The vibration isolator according to claim 29, further comprising:

an accelerometer operably associated with the housing for sensing the harmonic vibration of the rotating machinery as the speed of the rotating machinery changes.

35. A method of controlling the acoustic radiation of a ship comprising the steps of:

providing a tunable vibration isolator having a housing, a vibrating piston, and a tuning piston;

connecting the housing to a hull of the ship;

connecting the vibrating piston to a vibrating body on the ship; and

selectively tuning the frequency of the tuning piston to preclude the transmission of structural-borne vibration from the vibrating body to the hull of the ship.

36. The method according to claim 35, wherein the step of selectively tuning the frequency of the tuning piston is achieved by selectively actuating the tuning piston with at least one actuator.

37. The vibration isolator according to claim 36, wherin the actuator is a piezoelectric actuator.

38. A vibration isolator comprising:

a housing;

a piston resiliently disposed within housing, the piston being adapted for connection to a first body;

a first fluid chamber and a second fluid chamber defined by the housing and the piston;

a tuning port placing the first fluid chamber and the second fluid chamber in fluid communication;

a tuning fluid disposed within the first fluid chamber, the second fluid chamber, and the tuning port; and

at least one solid-state actuator operably associated with the tuning fluid to counteract vibration from the vibrating body.

39. The vibration isolator according to claim 38, wherein the solid-state actuator is an electrostrictive material.

40. The vibration isolator according to claim 38, wherein the solid-state actuator is a magnetostrictive material.

41. A vibration isolator comprising:

a housing;

a piston resiliently disposed within housing, the piston being adapted for connection to a first body;

a first fluid chamber and a second fluid chamber defined by the housing and the piston;

a tuning port placing the first fluid chamber and the second fluid chamber in fluid communication;

a tuning fluid disposed within the first fluid chamber, the second fluid chamber, and the tuning port; and

at least one actuator operably associated with the tuning fluid to counteract vibration from the vibrating body.

42. The vibration isolator according to claim 41, wherein the actuator is a electromagnetic actuator.

43. The vibration isolator according to claim 41, wherein the actuator is a pneumatic actuator.

44. The vibration isolator according to claim 41, wherein the actuator is a hydraulic actuator.